Results on main cephalopods species captured in the bottom trawl surveys in the Porcupine Bank (Division VIIc and VIIk)

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Abstract

This working document presents the results of the significant cephalopods in the Spanish Ground Fish Survey on the Porcupine bank (SPPGFS) from 2001 to 2011. The species more abundant in biomass terms in these surveys are curled octopus (Eledone cirrhosa), European flying squid (Todarodes sagittatus), seven-arm octopus (Haliphron atlanticus), Northern European squid (Loligo forbesi), globose octopus (Bathypolypus sponsalis), lesser flying squid (Todaropsis eblanae), broadtail shortfin squid (Illex coindetti) and stout bobtail squid (Rossia macrosoma). Biomass, distribution and length ranges were analysed. Most of the species occur in the shallower areas, except T. sagittatus, H. atlanticus and B. sponsalis that were mainly found in the deep strata.

Introduction

The Porcupine Bank bottom trawl survey has been carried out annually since 2001 to provide data and information for the assessment of the commercial fish species in the area (ICES divisions VIIc and VIIk) (ICES, 2010). During these 11 years of surveys, the cephalopods have occurred frequently but they have little reported and assessed.

The aim of this working document is to report the geographic and bathymetric distribution, relative abundance and biological parameters of the main cephalopods species in the area from 2001 to 2011. The most common species in the survey time series are analysed in the present working document, namely *Eledone cirrhosa and Bathypolypus sponsalis* (fam. Octopodidae), *Haliphron atlanticus (*fam. Alloposidae*)*, *Todarodes sagittatus*, *Todaropsis eblanae* and *Illex coindetii* (fam. Ommastrephidae), *Loligo forbesi* (fam. Loliginidae) and *Rossia macrosoma* (fam. Sepiolidae).

Material and methods

The Spanish Ground Fish Survey on the Porcupine bank (SPPGFS) has been carried out every autumn since 2001 on board the board the R/V "Vizconde de Eza", the stern trawler of 53 m and 1800 Kw.

The sampling design used was random stratified to the area, with two geographical sectors (North and South) and three depth strata (> 300 m, 300 – 450 m and 450 - 800 m) (**Figure 1**). This stratification was adopted in 2003, following the results of the two first surveys in the area. The results from the first two years were also reviewed according to the new stratification (Velasco and Serrano, 2003, ICES 2010). In each survey around 80 hauls are performed in the area. Hauls, performed with a Porcupine

Baca 40/52 otter trawl, last 30 minutes and are carried out during daylight, as described in the IBTS manual for the Western and Southern areas (ICES, 2010) where details on the sampling protocol are explained. Sampling was random stratified and allocated proportionally to strata area using a buffered random sampling procedure (as proposed by Kingsley *et al*., 2004) to avoid the selection of adjacent 5×5 nm rectangles. Cephalopods species are identified and sorted at the end of each haul, and since 2008, following IBTS protocols, length distributions are collected for the most common cephalopod species.

Two different methods were used to estimate abundance variability: (i) the parametric standard error derived from the random stratified sampling (Grosslein and Laurec, 1982), and (ii) a non parametric bootstrap procedure implemented in R (R Development Core Team, 2008) re-sampling randomly with replacement stations within each stratum and maintaining the sampling intensity, and using 80% bootstrap confidence intervals from the 0.1 and 0.9 quantiles of the resultant distribution of bootstrap replicates (Efron and Tibshirani, 1993). Geographical and bathymetric distributions of the most common species are analysed in biomass and number terms for the eleven years of the overall time series. Length distributions data just were collected from 2008 to 2011 and results are presented only for these years.

Results

Cephalopods represent a relatively small percentage of the invertebrates mean stratified biomass caught (4%) and of the mean stratified abundance (1%), but about 54% and 81% of the molluscs mean stratified biomass and abundance caught respectively.

The two species with larger stratified biomass were curled octopus *(Eledone cirrhosa)* and European flying squid *(Todarodes sagittatus),* then seven-arm octopus *(Haliphron atlanticus)* and long finned squid *(Loligo forbesi),* and lastly globose octopus *(Bathypolypus sponsalis),* lesser flying squid *(Todaropsis eblanae),* broadtail shortfin squid (*Illex coindetti*) and stout bobtail squid (*Rossia macrosoma).* However, there are differences in numeric abundance terms. *T. eblanae* and *I. coindetti* showed more abundance than *L. forbesi* while *H. atlanticus* showed marked lower abundances than *B. sponsalis* and *R. macrosoma*.

Some patterns of geographical distribution were observed in *E. cirrhosa* and *T. eblanae* which are mainly found in the North sector and close around the central mound of the Bank. Therefore, most of the species showed a higher percentage of occurrences in the shallower depth strata, below 300 m, although *T. sagittatus* also occurred frequently deeper than 450 m while the octopus *H. atlanticus* and *B. sponsalis* showed a narrower and deeper bathymetric range.

Although length size data have been collected for few years, some trends have been observed. *T. eblanae* showed lower sizes and *T. sagittatus* showed wider length size range than the other Ommastrephids. Finally, modes were observed in all species, although could not be followed during the four years.

Curled octopus *(Eledone cirrhosa)*

This species represented about 34% of the cephalopods mean stratified biomass caught and about 30% of the cephalopods mean stratified abundance. The stratified biomass and abundance trend were similar and showed two peaks in 2005 and 2007 (Figure 2).

E. cirrhosa was mainly found in the North sector, close around the Bank and in the east of the area close to the Irish shelf. It showed a depth range between 189 and 759 m, although in the overall time series it occurred in the 90% of the hauls shallower than 300 m (Figure 3).

The length size of the last four surveys ranged from 1 to 13 cm. In 2008 and 2010, larger sizes than 2009 and 2011 and a possible mode between 6 and 7 cm were found (Figure 4).

European flying squid *(Todarodes sagittatus)*

T. sagittatus represented about 30% of the cephalopods mean stratified biomass caught while it just showed about 10% of the stratified abundance caught. *T. sagittatus* stratified biomass trend was quite steady, although a higher capture was found in 2003 (Figure 5).
T. sagittatus extended throughout the Porcupine area from 190 to 763 m. Higher biomass were found in the deepest South and North sector in some years (2001, 2002, 2004, 2010, 2011) and in the deepest depth strata between 450 and 800 m. However, the species occurred between the 30 and 50% of the hauls in all depth strata, showing a wider bathymetric range than the other species (Figure 6).
The minimum length size of *T. sagittatus* in the last four years, were 10 cm in 2011 and the maximum 48 cm in 2008. A mode around 22 cm and 23 cm was evident in 2008, vaguely marked in 2009 and absent among the low values of 2010 and 2011(Figure 7).

Lesser flying squid *(Todaropsis eblanae)*

This species represented a small percentage of the cephalopods mean stratified abundance caught (7%) and of the stratified biomass caught (5%). The stratified biomass showed a smoother trend than stratified abundance trend. The abundance peaks in 2005 and 2009 represented little increases in biomass (Figure 8).
T. eblanae was mainly found in the North sector, close to the southern part of the central mound of the Bank and in the eastern area close to the Irish shelf. It extended from 189 to 719 m and occurred in about 61% of the hauls shallower than 300 m in the overall time series (Figure 9).
Most of the specimens of this species showed little sizes to 10 cm, even a marked mode in 6 cm were found in 2009, but some larger specimens about 20 cm was also observed in 2010 (Figure 10).

Broadtail shortfin squid *(Illex coindetii)*

This species also represented a small percentage of the cephalopods mean stratified abundance caught (7%) and biomass caught (4%). The stratified biomass and abundance were low in the overall time series, although two marked peaks were found in 2007 and 2009, of which the former year was quite lower in the stratified biomass trend (Figure 11).
No clear pattern was found in the geographical distribution of *I. coindetti*. The bathymetric distribution showed the majority of biomass in the shallowest depth strata, below 300 m, although this species was found from 200 to 724 m (Figure 12).
There were few size measurements to analyse the length size trend in that species, even so the specimens ranged from 6 to 21 in the last four years and 2009´ sizes showed a mode around 16 cm (Figure 13).

Long finned squid *(Loligo forbesi)*

L. forbesi represented about 7% of the cephalopods mean stratified biomass caught and 3% of the stratified abundance caught in the overall time series. The stratified biomass and abundance of *L. forbesi* increased from 2008, after seven years of very low values, showing a peak in 2009 (Figure 14).
This species was mainly found in the North sector, close around the Bank and in the shallower eastern area. It dwelled between 189 and 507 m, although higher biomass was found below 300 m (Figure 15).

L. forbesi showed a wide length size range, like that of *T. sagittatus*. It ranged from 9 to 47 cm in the last four surveys. A mode around 16 and 17 cm and a smaller one around 13 cm were found respectively in 2009 and 2011(Figure 16).
The two species of *Loligo* have been reported in the area (Lordan *et al*, 2011). *L. forbesi* is the most numerous species in catches of the cephalopods, while *L. vulgaris* have been occasionally caught, following these authors, who also recognize that the identification of the both *Loligo* species is especially difficult in smaller specimens, this fact that may have also affected our results. Even so, a special effort will be made to distinguish between both species in following years.

Other species

Although *Haliphron atlanticus*, *Bathypolypus sponsalis* and *Rossia macrosoma* also represented a small percentage of the cephalopods mean stratified biomass caught (13%, 5%, 1%, respectively) and abundance (1%, 4% and 6%, respectively), some trends have been observed. A slight decrease was found in the stratified biomass trend of *H. atlanticus* in the last four years, while a steady abundance was observed in *B. sponsalis* in the overall time series (Figure 17, Figure 19).
H. atlanticus and *B. sponsalis* were not found in depths shallower than 300 m in the overall time series. They dwelled respectively from 358 to 763 m and from 309 to 762 m. High biomass of *H. atlanticus* and *B. sponsalis* were found in the deepest South and North sector. Although the former species showed more biomass, it just occurred in about 18% of the hauls deeper than 450 m, while the latter, which was more abundant in number, occurred in about a half (49%) of that hauls (Figure 18, Figure 20).
R. macrosoma showed a steady stratified biomass trend, except the high amount of the first year of the series (Figure 21). In abundance terms, it mainly extended in the North sector from 192 to 760 m in the overall time series, although the higher abundances were found shallower than 450 m (Figure 22).

Acknowledgements

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Figures

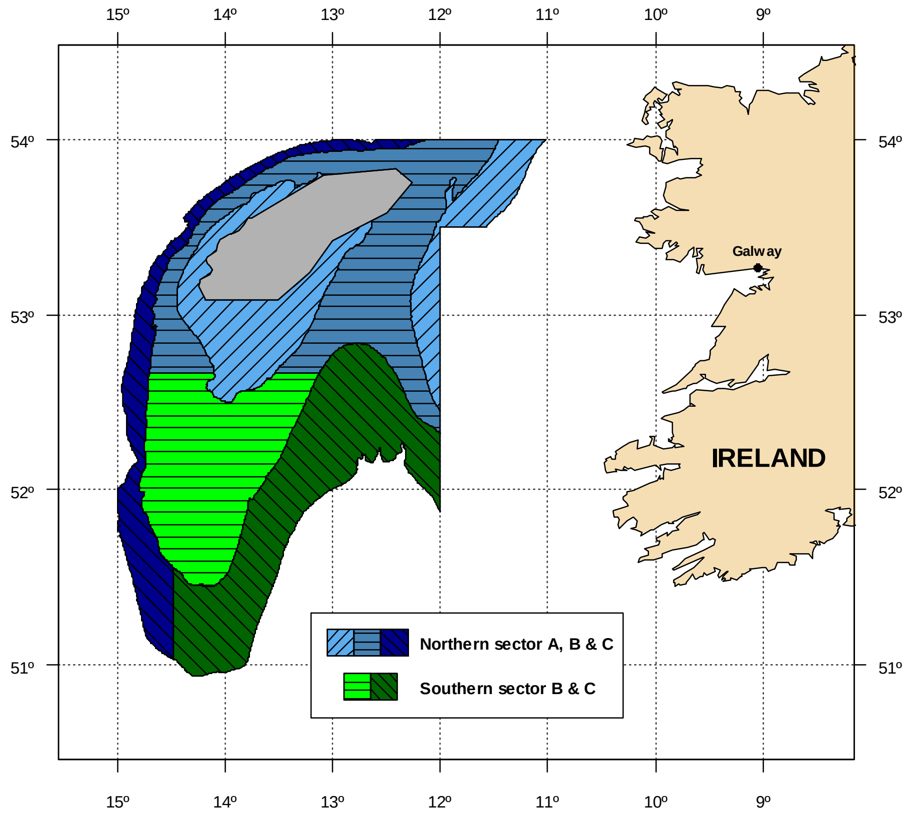


Figure 1 Stratification design of the Spanish Ground Fish Survey in the Porcupine Bank (IBTS: SPPGFS) with the depth strata > 300 m, 300 – 450 m and 450 - 800 m and the two geographic sectors, North (blue colours) and South (green colours).

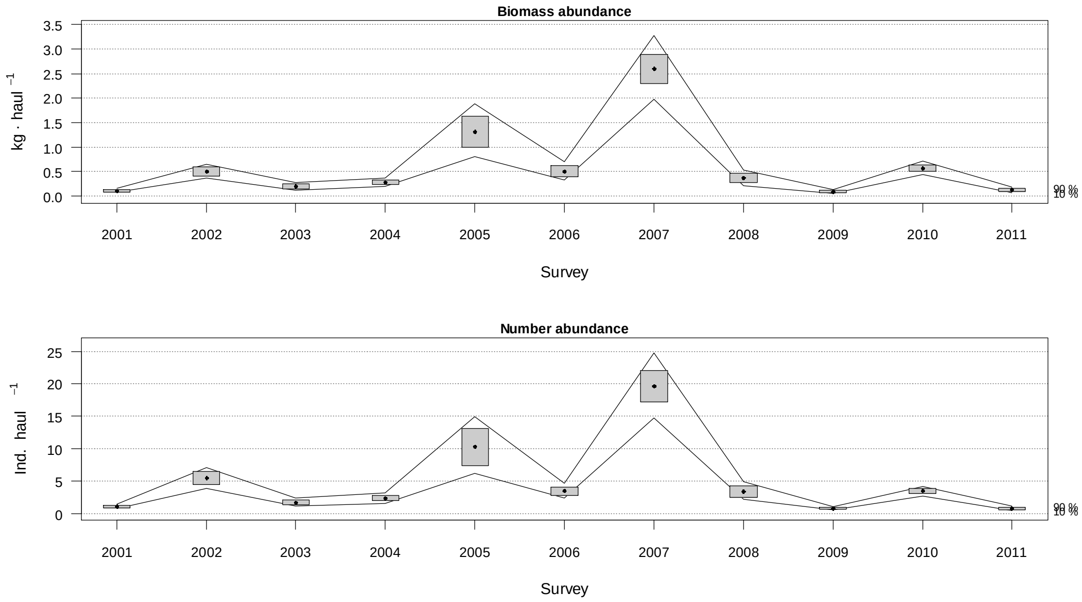
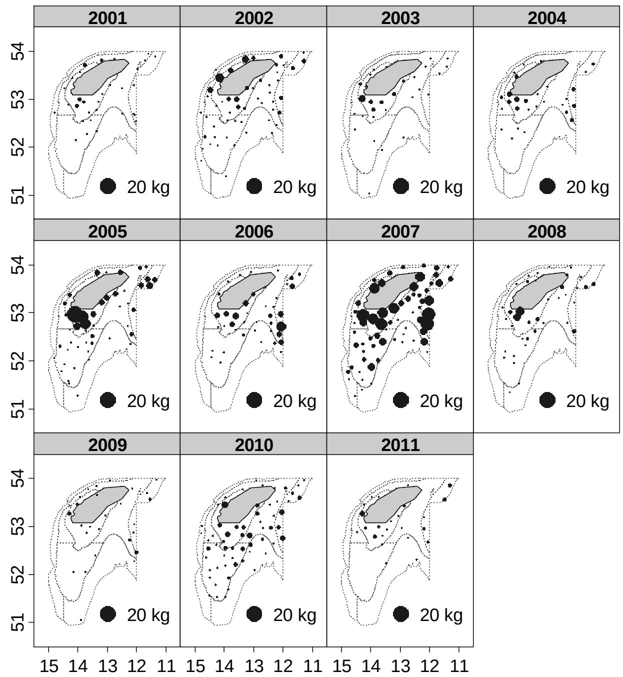


Figure 2 Evolution of *Eledone cirrhosa* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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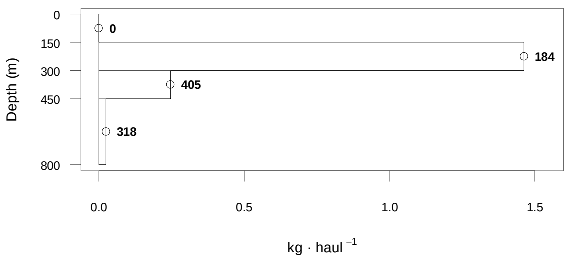


Figure 3 a) Geographic distribution of *Eledone cirrhosa* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *E. cirrhosa* in the Porcupine bank bottom trawl surveys (2001-2011)

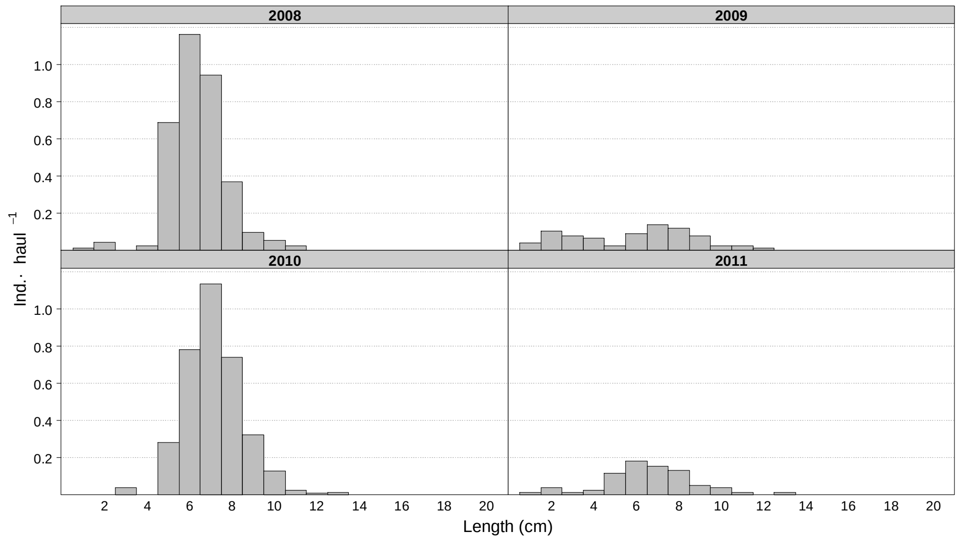


Figure 4 Mean stratified length distributions of *Eledone cirrhosa* in the Porcupine bank bottom trawl surveys (2008-2011)

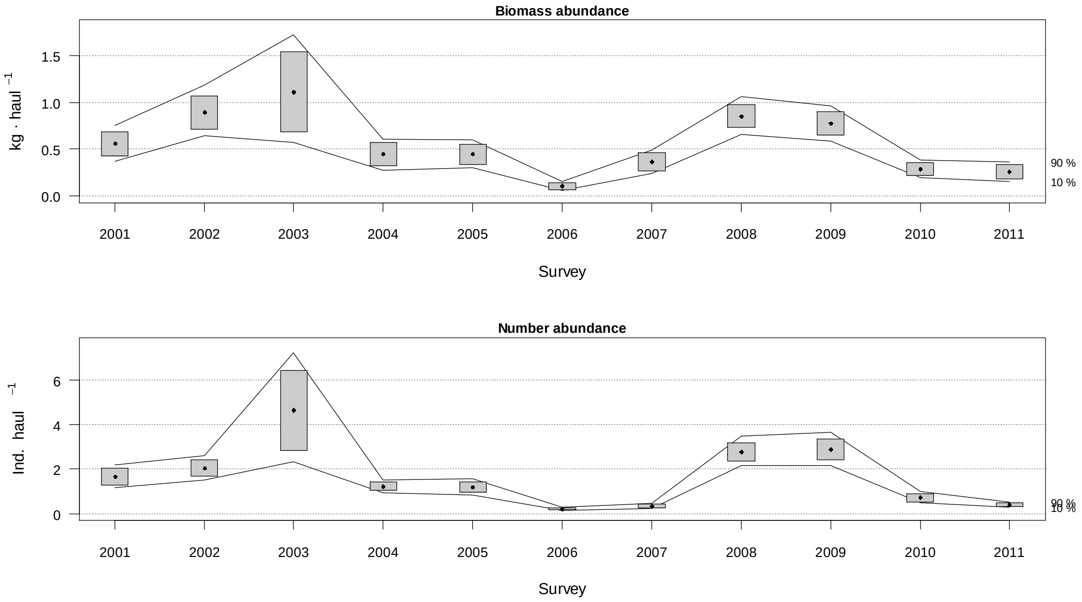
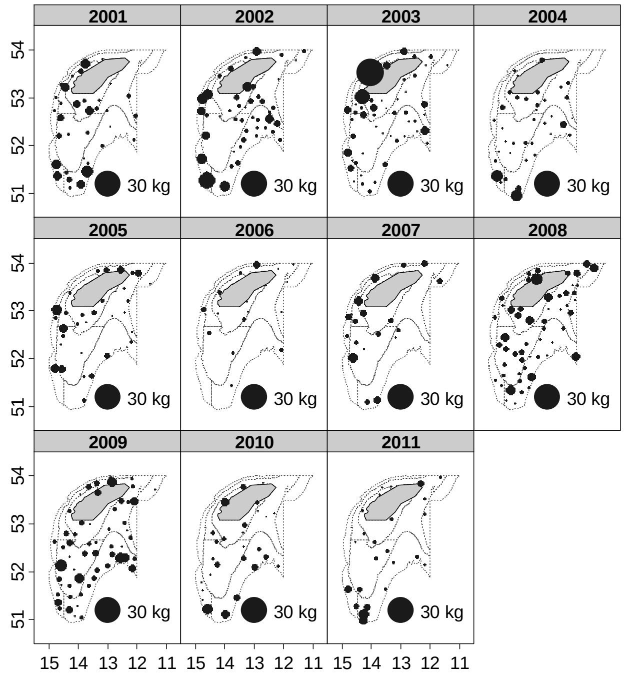


Figure 5 Evolution of *Todarodes sagitattus* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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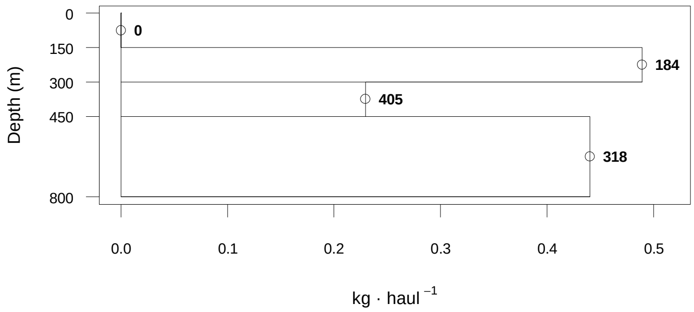


Figure 6 a) Geographic distribution of *Todarodes sagittatus* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *T. sagitattus* in the Porcupine bank bottom trawl surveys (2001-2011)

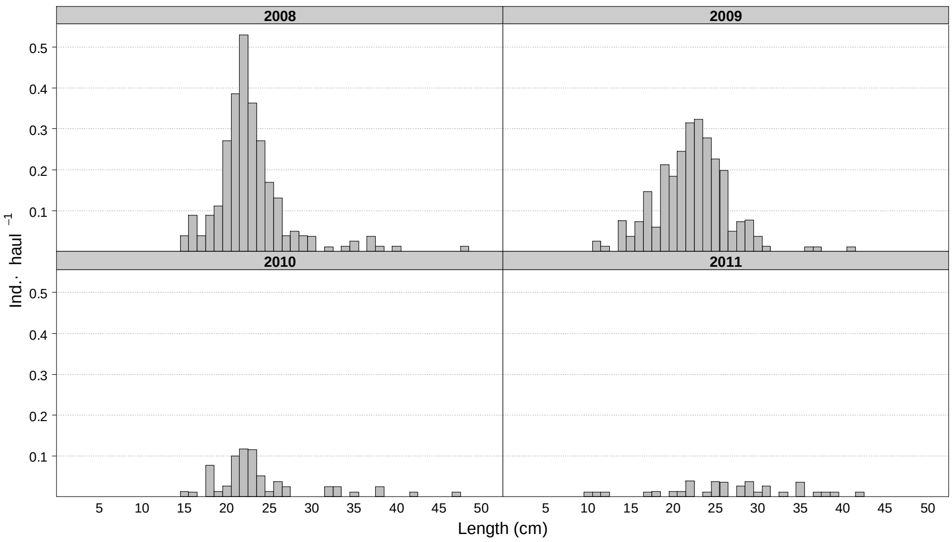


Figure 7 Mean stratified length distributions of *Todarodes sagitattus* in the Porcupine bank bottom trawl surveys (2008-2011)

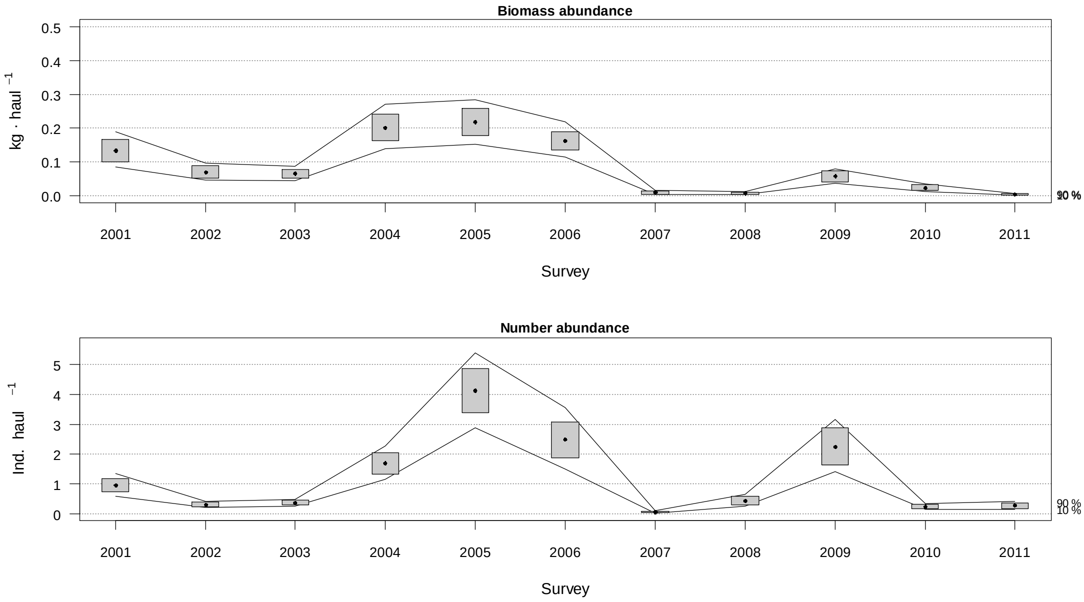
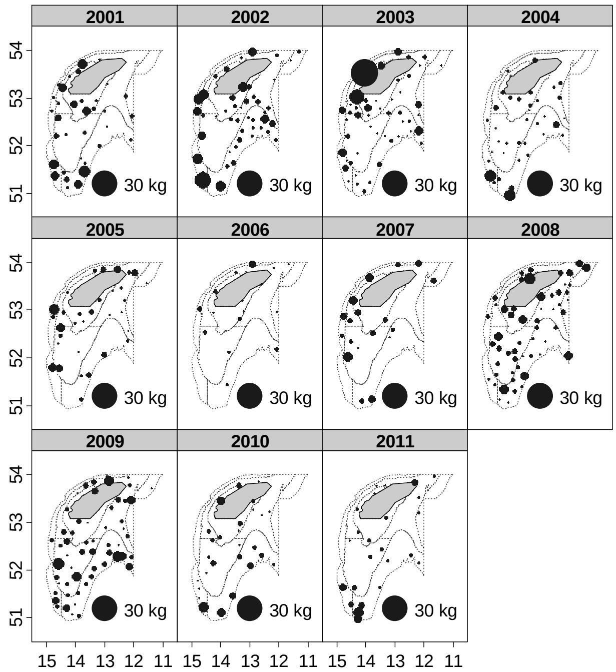


Figure 8 Evolution of *Todaropsis eblanae* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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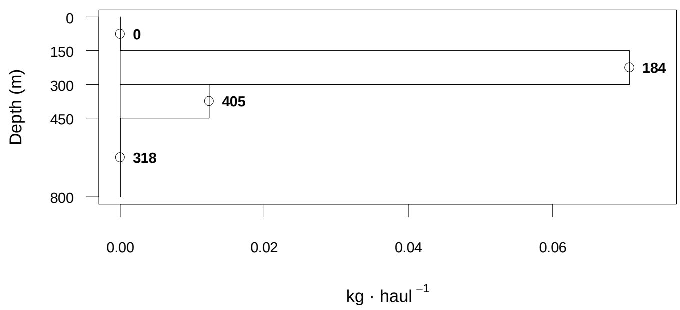


Figure 9 a) Geographic distribution of *Todaropsis eblanae* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *T. eblanae* in the Porcupine bank bottom trawl surveys (2001-2011)

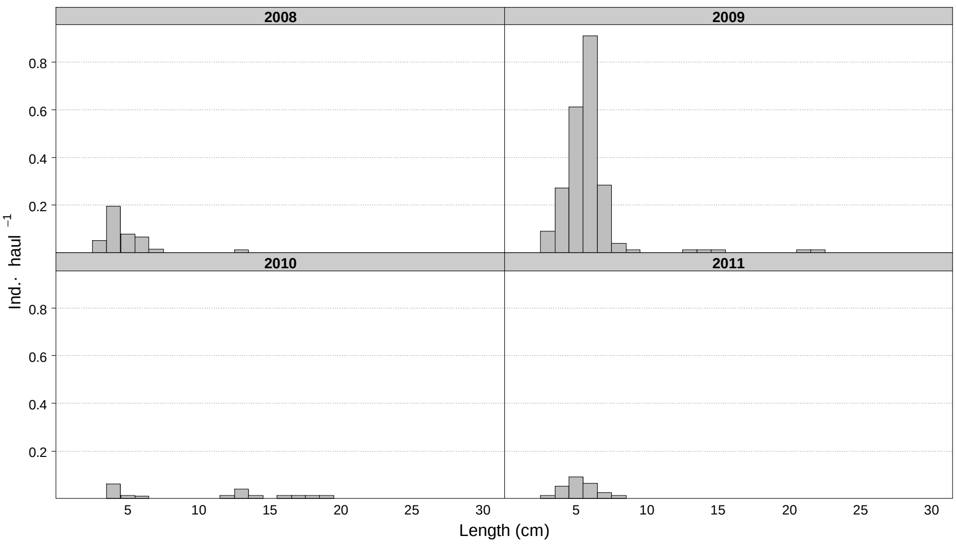


Figure 10 Mean stratified length distributions of *Todaropsis eblanae* in the Porcupine bank bottom trawl surveys (2008-2011)

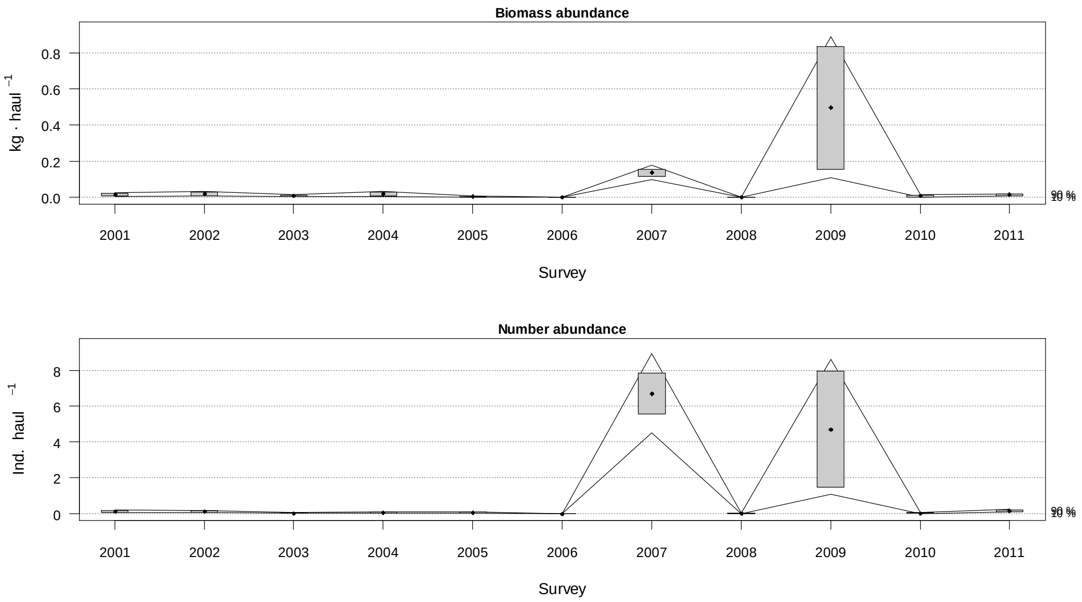
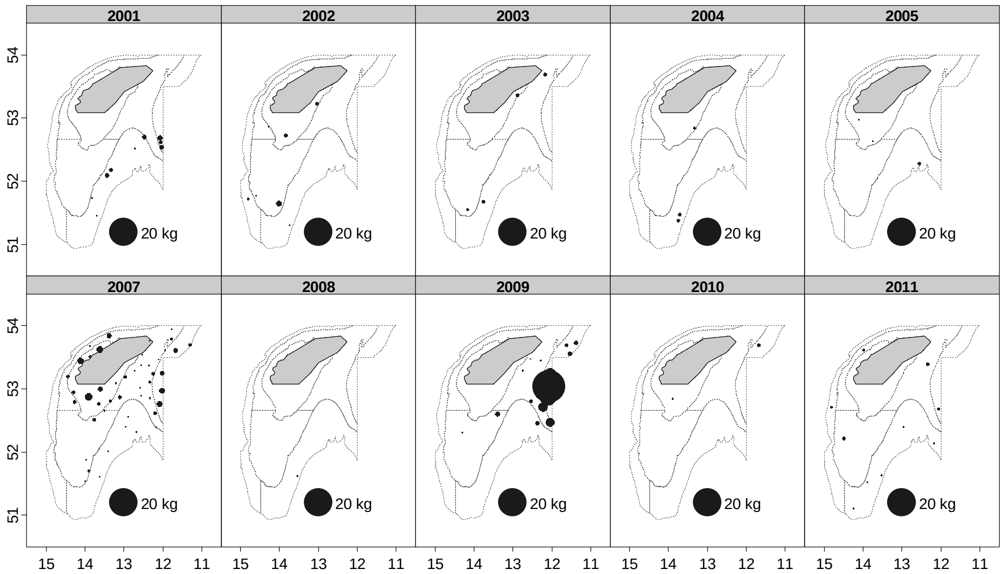


Figure 11 Evolution of *Illex coindetti* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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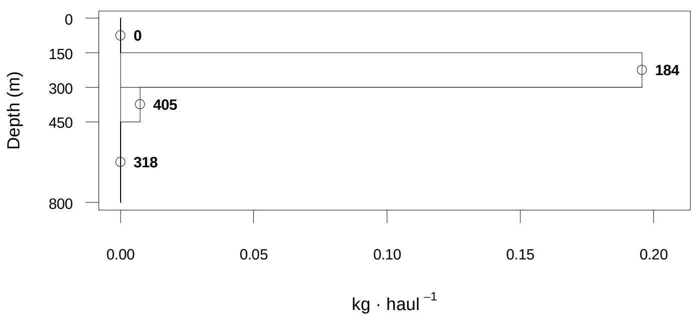


Figure 12 a) Geographic distribution of *Illex coindetti* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *I. coindetti* in the Porcupine bank bottom trawl surveys (2001-2011)

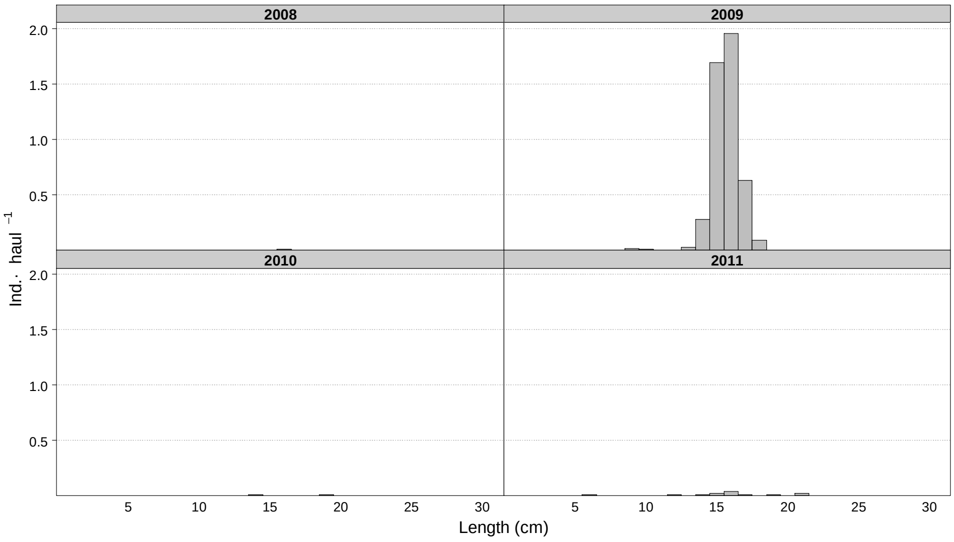


Figure 13 Mean stratified length distributions of *Illex coindetti* in the Porcupine bank bottom trawl surveys (2008-2011)

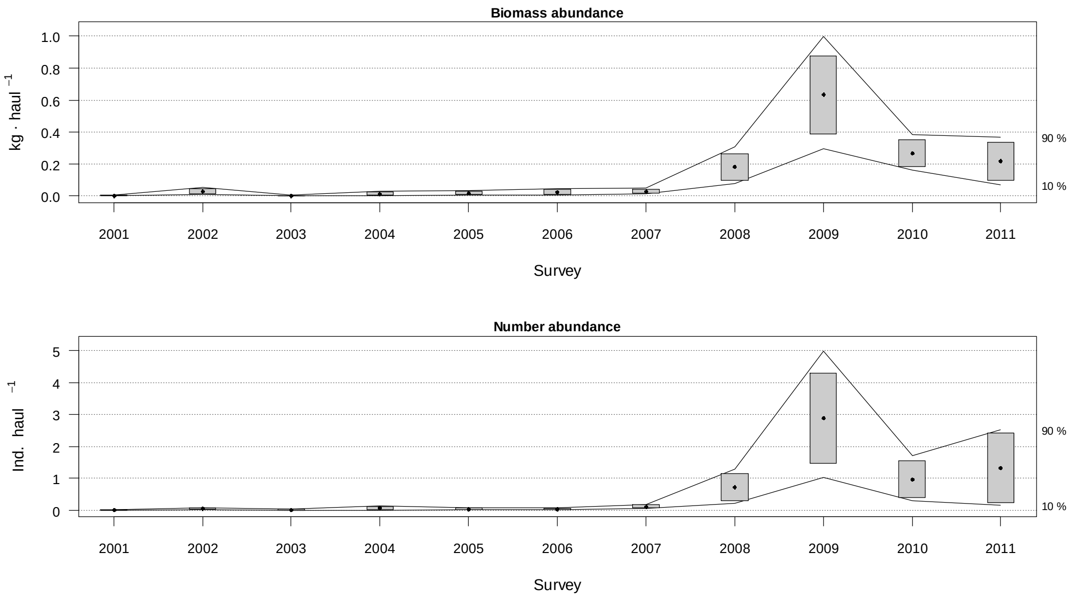
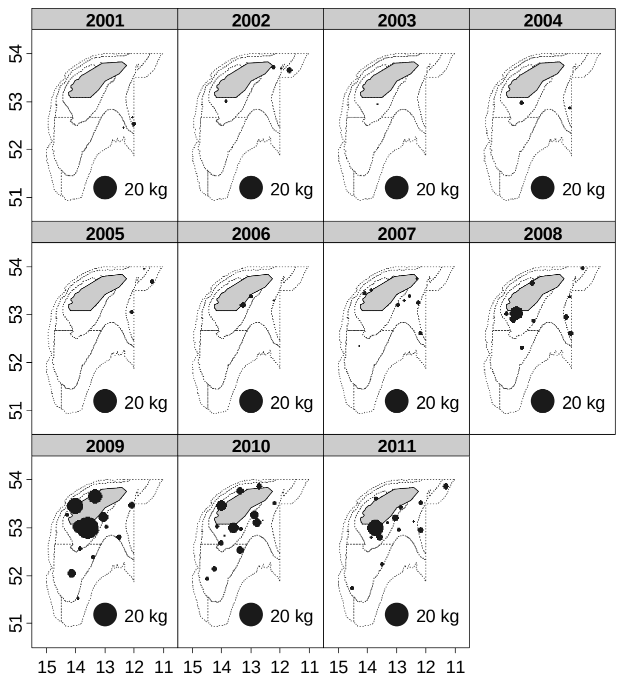


Figure 14 Evolution of *Loligo forbesi* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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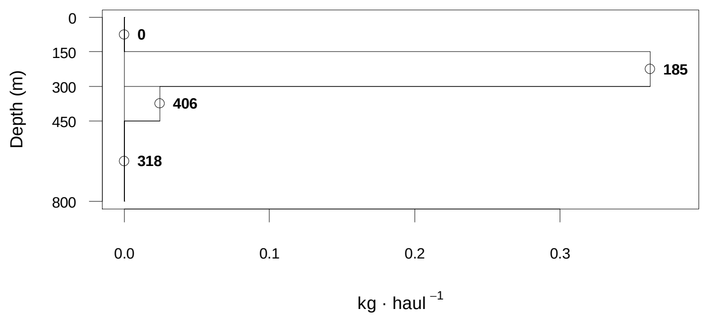


Figure 15 Geographic distribution of *Loligo forbesi* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011

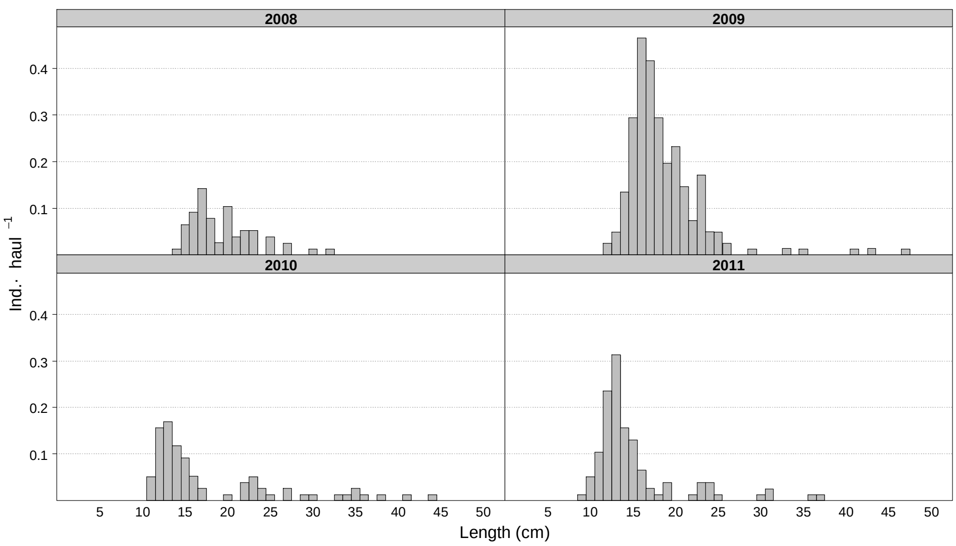


Figure 16 Mean stratified length distributions of *Loligo forbesi* in the Porcupine bank bottom trawl surveys (2008-2011)

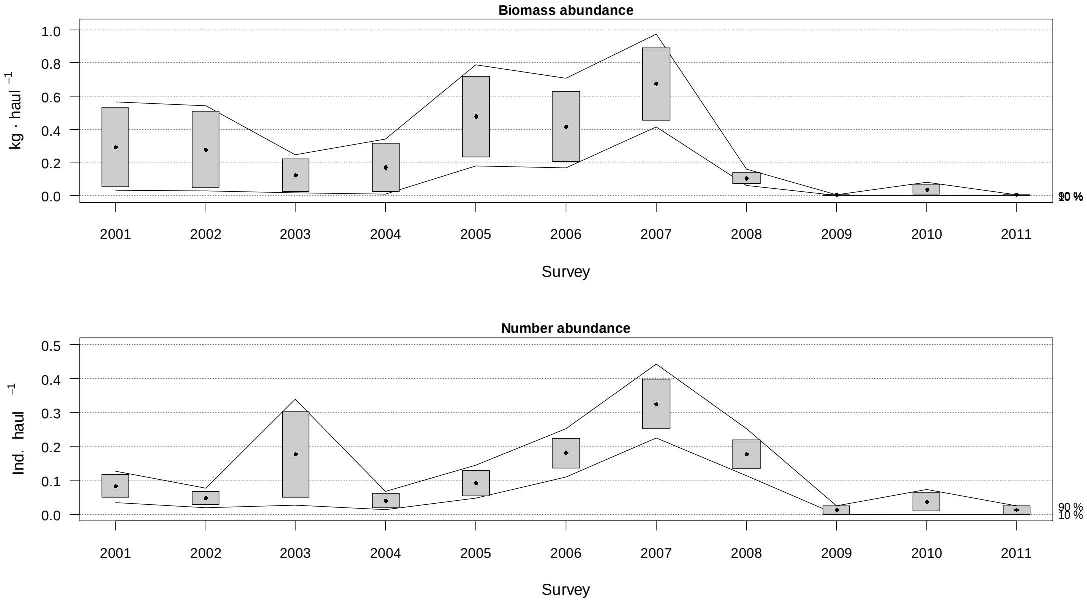
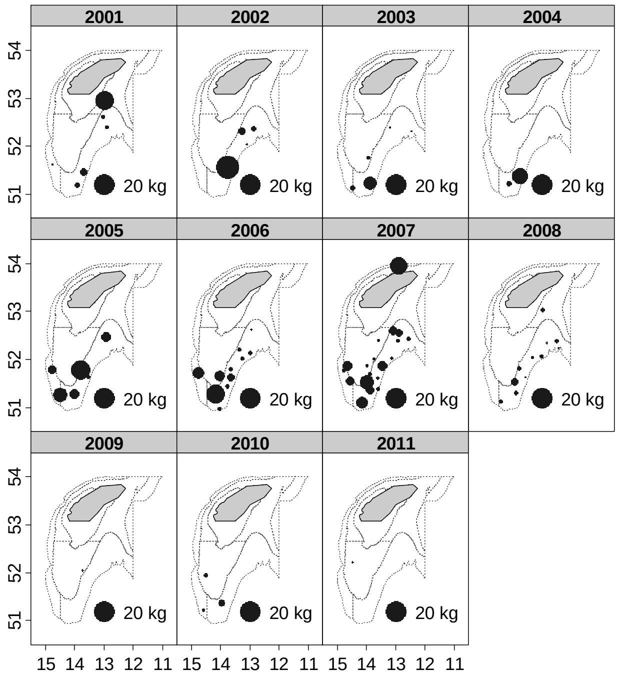


Figure 17 Evolution of *Haliprhon atlanticus* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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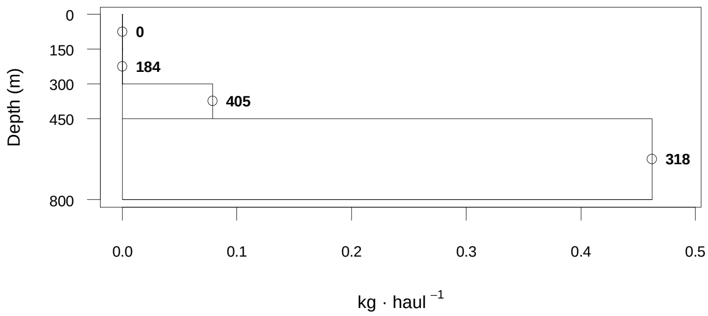


Figure 18 a) Geographic distribution of *Haliprhon atlanticus* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *H. atlanticus* in the Porcupine bank bottom trawl surveys (2001-2011)

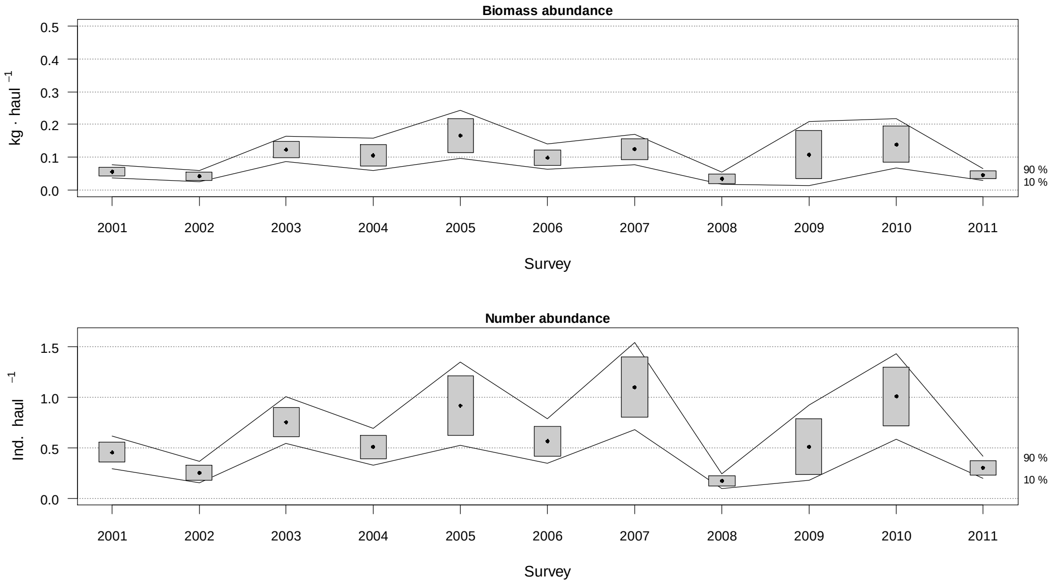
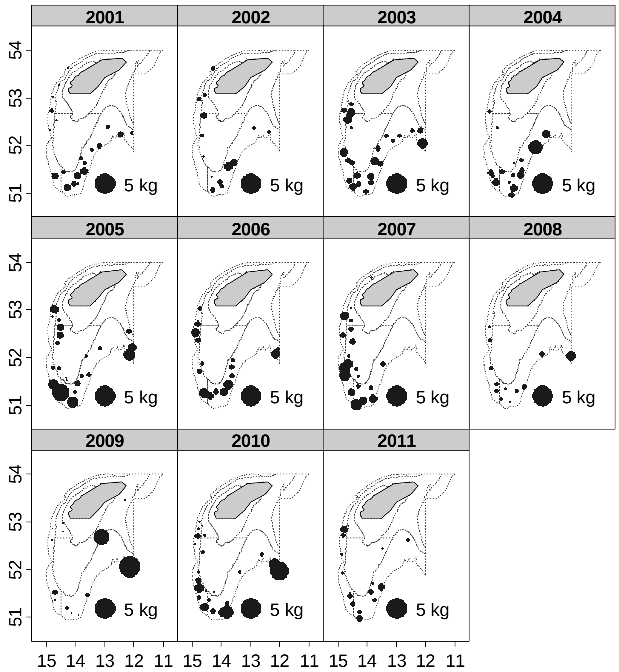


Figure 19 Evolution of *Bathypolypus sponsalis* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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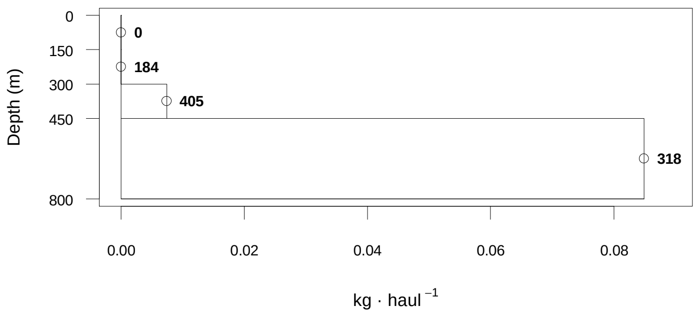


Figure 20 Geographic distribution of *Bathypolypus sponsalis* catches (kg/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric biomass profile of *B. sponsalis* in the Porcupine bank bottom trawl surveys (2001-2011)

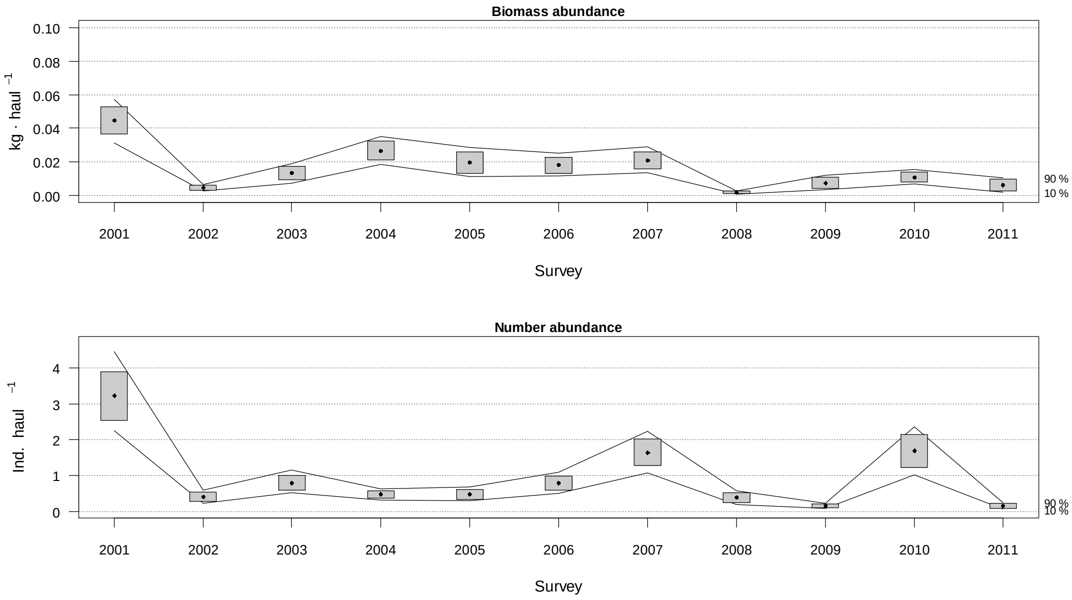
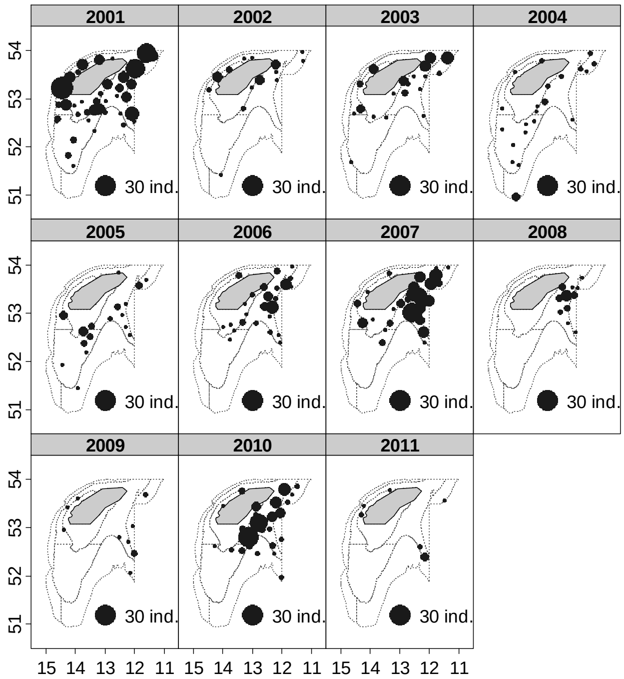


Figure 21 Evolution of *Rossia macrosoma* biomass index and abundance during the Porcupine bank bottom trawl survey time series (2001-2011). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals (α= 0.80, bootstrap iterations = 1000)

a)



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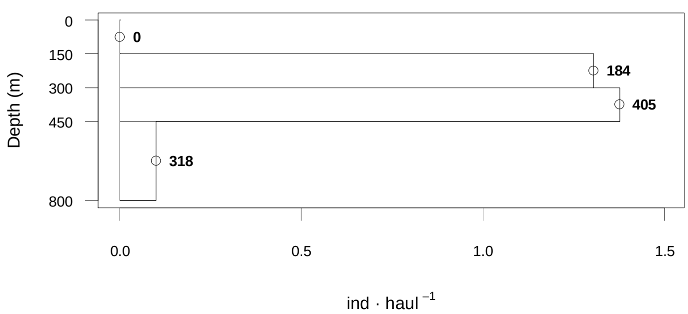

Figure 22 Geographic distribution of *Rossia macrosoma* catches (ind/30 min haul) in Porcupine bank bottom trawl surveys between 2001 and 2011. b) Bathymetric abundance profile of *R. macrosoma* in the Porcupine bank bottom trawl surveys (2001-2011)